Lybia Montes: A Safe, Ancient Cratered Terrain, Mars Surveyor Landing Site at the Isidis Basin Rim.

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Introduction: The Isidis basin rim may be key to under-standing Mars' past with future lander missions: this area enables the mission objective to explore Mars' climatic and geologic history, including the search for liquid water and evidence of prior or extant life in ancient terrains. While two safe candidate landing sites for Mars Pathfinder were identified in Isidis Planitia [1], and one is being pursued for the Mars Surveyor 2001 Lander [Crumpler: 3.4°N, 277.8°W], the region around Isidis Planitia, in contrast to Tharsis for example, has only been lightly studied [2,3,4,5,6]. The advent of new high resolution data sets provides an opportunity to re-assess the geologic context of this impact basin and its rim within the Martian geologic sequence as a candidate site for studying Mars' ancient cratered terrain and ancient hydrosphere. This re-examination is warranted by the various hypotheses that Isidis was once filled with ice or water [5,7,8,9,10].

Lybia Montes: Based on the stated landing site selection criterion of 50 m/pixel or better Viking imagery, we restrict ourselves to looking for safe landing sites within the Lybia Montes region of the Isidis Basin rim massif. In particular, we only consider the areas where Viking 20 m/pixel coverage exists from VL1 orbits 1137 and 1138 (locations shown in Figure 1). The area lies at the northern edge of the Mars Surveyor 2001 latitude range, around 272.5°W, 2.5°N. The elevations here are within the current engineering constraints. Future detailed MOLA data should be used to confirm this, as the elevations are near the upper limit, at around +2 km.

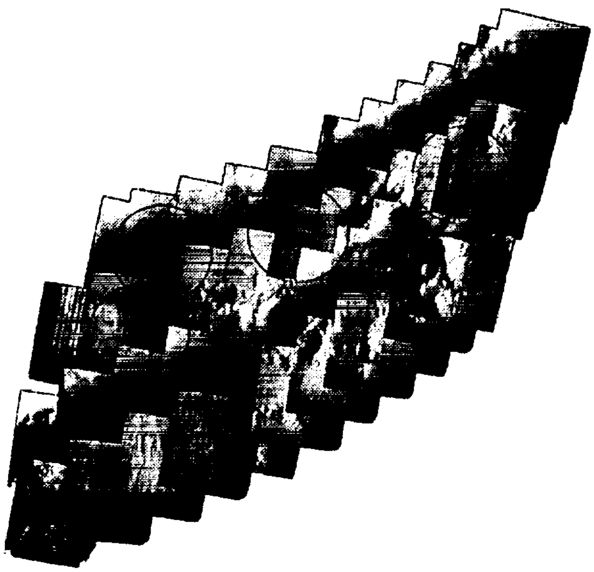
Greeley and Guest [4] map this region as unit Nplh, a Noachian hilly unit, interpreted as ancient highland rocks and impact breccia generated during heavy bombardment. Situated as it is on the Isidis Basin rim massif, this unit may offer an opportunity to sample Martian deep crustal rocks. Examination of the high resolution Viking images (Figure 2) shows that while the terrain is indeed rough and hilly, other processes have acted on the surface since heavy bombardment. The ancient cratered terrain is cut in many places by channels and gullies (see lower left portion of Figure 2), which have been previously analyzed [3]. These channels in the Viking images are of order 100 m across, and might pose a slope hazard for landing.

There are also areas of more homogeneous appearance, and topographically flatter, that lie between the rough hills and heavily cratered areas in our Lybia Montes scene. It is these locations that we believe offer interesting target landing sites. These surfaces may contain a sampling of the ancient cratered terrain rocks brought down the nearby channels, aeolian, fluvial, hydrothermal, and/or ejecta materials from more recent craters reworking the ancient brecciated surface. As it is unavoidable that any exposed rocks will have experienced weathering since their emplacement, these locations suggest that the Lybia Montes offers a safe way to reach samples of ancient cratered terrain rocks.

IRTM thermal inertias are low in our target area ($\sim 3\times10^{-3}$ cal cm^{-2} s$^{-0.5}$ K^{-1}), suggesting that it is dusty. At the same time, rock abundance maps suggest that the area has ~12% rock coverage. These contradictory observations, which on first look would exclude these sites, bear further study. We suggest that the spatial resolution of these properties is responsible. The inter-massif channel plains unit, in which we propose our target sites, are sampled by the more southerly nearby MOC image (Figure 1). The MOC image is apparently devoid of aeolian dune deposits, suggesting that this unit is stable, and thereby less dusty than previously identified. Additionally, Phobos ISM data [12] suggest that the southern Isidis Basin rim shows less hydrated minerals than the Isidis Basin itself. This may indicate that our candidate landing sites on the basin rim massif are significantly less dusty than the adjacent impact basin.

Figure 1. Viking regional context for this landing site study. Image extends from about 276°W to 268°W and from about 0°N to 6°N. The area with 20 m/pixel Viking image coverage is outlined. The white stripes indicate pre-mapping phase MGS MOC images.

Figure 2. Mosaic of 20 m/pixel Viking image coverage in Lybia Montes (Isidis Basin Rim Massif) centered at 272.5°W and 2.5°N. Four (approx. 25 km diameter circles: Southwest, Northwest, Middle, and East) are placed in regions that appear safe for landing and roving.



Summary: Four target landing sites are proposed in the inter-massif channeled plains in the Lybia Montes (LM) of the southern Isidis Basin rim massif: Southwest (LMSW 273.0°W, 2.8°N), Northwest (LMNW 272.9°W, 3.0°N), Middle (LMM 272.5°W, 3.0°N), East (LME 272.0°W, 3.1°N). These sites all lie in reworked and/or altered ancient cratered highlands materials. The geographic locations, in the Viking cartographic frame, are at the northern latitude range limit. These sites are at acceptable elevations near +2 km. These sites all have 20 m/pixel Viking image coverage. It is somewhat contradictory that these sites are both somewhat too rocky (<13%), as well as somewhat too dusty (both fine component and bulk thermal inertias ~3×10^{-3} cal cm^{-2} s$^{-0.5}$ K^{-1}), and we suggest that, based on nearby MOC images in similar terrain, the sites are in fact acceptable in both regards. Surface slopes are not yet known; radar tracks do not cross this location. From visual inspection of the 20 m/pixel Viking images and of MOC images, they appear in acceptable range.

References: [1] Golombek et al., (1997) *J. Geophys. Res.*, 102, 3967-3988. [2] Schultz et al., (1982), *J. Geophys. Res.*, 87, 9803-9820. [3] Schultz and Britt, (1986), *LPSC XVII*, 775-776. [4] Greeley and Guest, (1987) *U.S.G.S. Misc. Invest. Ser. Map*, I-1802-B. [5] Grizzaffi and Schultz, (1989), *Icarus*, 77, 358-381. [6] Schultz and Frey, (1990), *J. Geophys. Res.*, 95, 14175-14189. [7] Lucchitta, (1981) *Icarus*, 45, 264-303. [8] Rossbacher and Judson, (1981), *Icarus*, 45, 39-59. [9] Rossbacher, (1985), *Models Geomorphol.*, 343-372. [10] Parker et al., (1993), *J. Geophys. Res.*, 98, 11061-11078. [11] James et al., (1998), *NASA Tech. Memo.*, 98-206538, Houston. [12] Erard et al., (1990), *LPSC XXI*, 327-328.